NAS 1.46: 15/7

DOCUMENTS

NASA Activities

National
Aeronautics and
Space
Administration

July 1984
Vol. 15, No. 7

EASTERN MICHIGAN UNIVERSITY
YPSILANTI
U. S. DEPOSITORY DOCUMENT

AUG 2 2 1984

About the Cover

A quarter of a million miles from earth, between a boulder field and circle of craters, there is a small memento to an immeasurable human triumph. The object is a steel plaque bolted to the primary strut, or landing leg, of the U.S. lunar module, The Eagle. It bears a map of the world and this inscription:

Here men from the planet Earth
first set foot upon the Moon
July 1969 A.D.
We came in peace for all mankind

The visitors stayed for less than a day. They walked in a setting unlike anything in their world and pressed their footprints into a substance that had been undisturbed for several billion years. When the ascent stage of the Eagle flew away, the landing gear and its inscription were left to the stark silence of the lunar surface.

July 20 marks the 15th anniversary of the first manned lunar landing. On July 16, 1969, in a classic on-time liftoff, Apollo 11 roared from Pad 39A at Kennedy Space Center, Fla., to begin its historic journey to the moon. On the fifth day of that mission the lunar module, Eagle, touched down on the lunar surface and man first stepped out onto the moon.

The first print made by the weight of man on the moon is that of a lunar boot which resembles an oversized gaslosh.

Below, the Apollo 11 crew (from the left): Neil A. Armstrong, Commander; Michael Collins, Command Module Pilot; and Edwin E. Aldrin Jr., Lunar Module Pilot.

The Log of Apollo 11 found on page 10 presents an account of this historic event.

Contents

Administrator's Column 3
President Features Space Station at London Economic Summit 3
Spacelab 3 and 2 Payload Specialists Named 4
New NASA Educational Program for Science and Math 5
New Publications Available 7
What's New in NASA Television and Radio Programming 7
NASA to Participate in 32nd Annual EAA Convention and Sport Aviation Exhibition 8
Patents for Inventions from NASA Research 9
Auto Technology Feasible for Aircraft Applications 9
Log of Apollo 11 10
Crew Members Named for Future Space Shuttle Flights 18
Crew Member Added to Shuttle Mission 41-G ... 18
NASA Works to Improve Aerial Application of Chemicals 19
Agency-Sponsored Development Opportunities .. 21
Contractor News 22
1984 Launch Activity 23
Another Dividend from Air and Space 24

NASA Activities is published monthly by the National Aeronautics and Space Administration for the information of the agency's employees. Contributions and recommendations are solicited from Headquarters and field centers, and should be addressed to Editor, NASA Activities, News and Information Branch, Code LFD-2, Washington, D.C. 20546. Material submitted for publication cannot be returned.

Distributed free of charge only to current agency employees. Available by subscription from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Check or money order should be made payable to Superintendent of Documents, GPO. Subscription rates are $23.00/year, domestic; $28.75/year, foreign.

Barbara E. Selby
Editor, Code LFD-2
NASA Headquarters
Washington, D.C. 20546
Phone: (202) 453-8400

NAS1.46:15/7

ADMINISTRATOR'S COLUMN

(In this column NASA Activities features an article by NASA Administrator James M. Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees.)

Quality Circles: A Lesson In Teamwork

Emerson once said, "There's always a best way of doing everything, even if it be to boil an egg."

Two years ago, NASA began an experiment to prove that point. Our goal was not to boil better eggs, but to stir the pot so that our people's inherent creativity and productivity would come out on top.

In order to do this we started a pilot program at Headquarters and several of our field centers to encourage employee participation in solving problems through teamwork. We borrowed the idea from industry, where it is known as Quality Circles.

I'm pleased to report that our Quality Circles—the NASA Employee Teams (NETS)—are stirring the pot at a great rate, and in the process, are making their mark. They are working steadily to improve the style and substance of our work at all levels of the agency.

We now have more than 70 NETS operating throughout the agency and we expect that number to grow.

We are learning that if employees are given an opportunity to become actively involved in problem-solving, management will not only listen, but will work hard with employees to improve things.

The key to our success is teamwork, a concept that is not new to NASA, since we have worked in concert with industry and the university community for years. But in applying that concept to ourselves and how we do things within the agency we are finding that maybe we aren't quite as perfect as we might have thought and that quality and productivity can indeed be enhanced if we work at it.

I believe our NETS also serve another important function. They make each individual that participates feel that he or she *can* make a difference, and that together we can work to make NASA a model for Federal productivity efforts.

I congratulate all who participate in this program. Keep stirring the pot and we will all be the better for it.

President Features Space Station at London Economic Summit

During the June London Economic Summit, President Reagan and the leaders of the other Summit nations gathered around a model of the U.S. permanently manned Space Station. In a lively discussion among the Summit participants, the President noted that the United States hopes to have the Space Station in orbit by the early 1990s. He pointed out that the facility will be used to manufacture high purity medicines and materials, to test and repair satellites, and to serve as a platform for further exploration of the universe.

The Economic Summit is an annual meeting of the leaders of the developed nations (the United States, the United Kingdom, Germany, Italy, France, Japan and Canada) and the European community. It is a forum for the discussion of economic and other issues impacting the participating nations.

The Space Station was one of the six major themes for the United States at this year's Summit. The project itself was characterized as a practical demonstration of our determination to lay a technological base for the future. Furthermore, as a senior administration official noted to the press at the Summit, "President Reagan's vision is a long-term partnership in the peaceful use of space—a permanent, fully international Space Station built by the United States with its friends and allies, and used by all nations as an operating environment in which to work and learn. It is the President's view that an international Space Station can provide a focal point for free world space operations well into the 21st century, and international cooperation in this program would provide a highly visible and mutually beneficial symbol of free world leadership and of the Summit nations' commitment to working together."

At the close of the Summit, the participants issued a communique. This document welcomed the U.S. invitation for international participation in its Space Station program, acknowledged the benefits of such a program to technological and economic growth, and noted that the Summit partners would examine the nature of their potential participation in the project. As a final point, the United States undertook to report on the status of international participation in the program at the 1985 Bonn Economic Summit. Upon French request, the communique also alluded to European interest in the eventual development of a European Space Station. Following is the text of the London Economic Declaration of June 9, 1984:

"We believe that manned space stations are the kind of programme that provides a stimulus for technological development leading to strengthened economies and

LIBRARY
EASTERN MICHIGAN UNIVERSITY
YPSILANTI
U. S. DEPOSITORY DOCUMENT

European Communities Commissioner Thorn, German Chancellor Kohl, British Prime Minister Thatcher, Italian Foreign Minister Andreotti, German Economics Minister von Lambsdorff and Japanese Prime Minister Nakasone, listen to President Reagan explain the Space Station program in front of model built by Langley Research Center.

improved quality of life. Such stations are being studied in some of our countries with a view to their being launched in the framework of national or international programmes. In that context each of our countries will consider carefully the generous and thoughtful invitation received from the President of the United States to other Summit countries to participate in the development of such a station by the United States. We welcome the intention of the United States to report at the next Summit on international participation in their programme."

The Summit meeting was an important and constructive step in the ongoing process of developing international programs complementary to the U.S. Space Station program. This process was begun in January with the President's invitation for international participation in the program; it was furthered by Administrator Beggs' March trip to the Summit capitals to reiterate the President's invitation. Future activities include international workshops to permit close collaboration through the project's design phase. The long-term goal of these efforts is meaningful, mutually beneficial international participation in the development, operation and utilization of the Space Station.

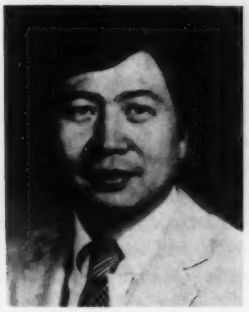
Spacelab 3 and 2 Payload Specialists Named

NASA has announced the selection of four career scientists to fly as payload specialists on the next two missions of Spacelab, a reusable Space Shuttle-based research facility.

Dr. Lodewijk van den Berg of EG&G Corporation, Goleta, Calif., and Dr. Taylor G. Wang of the Jet Propulsion Laboratory, Pasadena, Calif., were named flight payload specialists for Spacelab 3, scheduled for launch in January 1985. NASA also announced the selection of Dr. Mary Helen Johnston of the Marshall Space Flight Center and Dr. Eugene H. Trinh of the Jet Propulsion Laboratory to serve as alternate payload specialists for Spacelab 3.

Dr. Loren W. Acton of Lockheed Palo Alto Research Laboratory, Palo Alto, Calif., and Dr. John-David Bartoe of the Naval Research Laboratory, Washington, D.C., were named as flight payload specialists for Spacelab 2, which is now slated for launch in April 1985. NASA also named Dr. Dianne K. Prinz of the

Lodewijk van den Berg

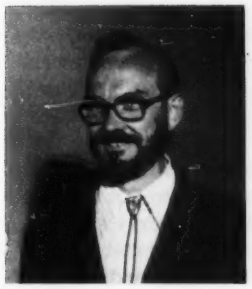


Taylor G. Wang

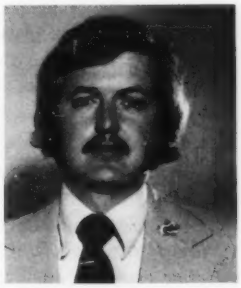
Naval Research Laboratory and Dr. George W. Simon of the Air Force Geophysics Laboratory, with permanent duty station at Sacramento Peak Observatory, Sunspot, N.M., as alternate payload specialists for Spacelab 2.

Spacelab 3 will be the first operational mission of the research facility. Conducting experiments requiring the low gravity environment of earth orbit is the prime mission objective. The mission emphasis is materials processing in space, a field which offers great commercial promise. Other major planned experiments have been selected from the fields of life sciences, environmental observations, technology research, astronomy and space plasma physics. Spacelab 3 will use the long version of the laboratory module, in which the scientists will work, and a special cargo bay instrument support structure.

Spacelab 2, which follows Spacelab 3 due to development delays in some of the equipment, includes experiments in the fields of solar physics, plasma physics, infrared astronomy, high energy physics, atmospheric physics, life sciences and technology. The configuration of Spacelab for this mission includes three pallets, which hold experiments requiring direct space exposure, an "igloo" which will contain Spacelab subsystems, and a special support fixture for a large cosmic ray experiment.



Loren W. Acton



John-David Bartoe

The mission will mark the first time the Spacelab will be flown without the habitable module. The crew will operate experiments remotely from the aft flight deck of the orbiter. It also marks the first flight of the Spacelab Instrument Pointing System. Both these missions are managed for NASA by the Marshall Space Flight Center, Huntsville, Ala.

The alternate payload specialists will act as flight backups and will play a major role in payload control operations from the ground throughout the mission.

In addition to the payload specialists, the Spacelab 3 flight crew will consist of Robert F. Overmyer, commander; Frederick D. Gregory, pilot; Dr. Don L. Lind, Dr. Norman E. Thagard, and Dr. William E. Thornton, mission specialists, all named previously to the mission.

Other Spacelab 2 flight crew members identified earlier are Charles G. Fullerton, commander; S. David Griggs, pilot; and Dr. F. Storey Musgrave, Dr. Anthony W. England, and Dr. Karl G. Henize, mission specialists.

New NASA Educational Program for Science and Math

Operation Liftoff, a new NASA Educational program, announced by President Reagan in June, is designed to encourage pupils in the nation's 75,000 elementary schools to take greater interest in mathematics and science.

The new program will rely on the development and refinement of information and materials in the NASA system and the creation of an expanded and more efficient delivery system utilizing the latest computer science and laser disk technology.

The key to success will be NASA's ability to develop and test "pilot" or "prototype" materials and concepts, and then to obtain private and community involvement in expanding their distribution into classrooms.

The program will cost $3 to $5 million over three years.

"For more than 25 years NASA has pioneered on the cutting edge of science and technology and has stimulated our young people to strive for excellence in all they do," the President said in a speech. His remarks were made at the dedication of the National Geographic Society's new building in Washington, D.C.

"Now NASA, in cooperation with the private sector, will expand its educational outreach program to our very young people in more than 75,000 elementary schools throughout the country. NASA will be able to share its

engineering know-how and scientific discoveries and sow the seeds of future progress by stimulating our young people to study science and engineering.

"We call this new program Operation Liftoff, and it will incorporate such advanced instructional tools as computer softwear, laser disks, and audiovisual materials and other techniques. It will also involve private enterprise. I have asked NASA to reinforce its ties with the aerospace industry and with private citizen's groups to expand this effort to the fullest.

"In this connection I was particularly pleased to learn of the efforts of the National Space Institute to develop and support a new national Young Astronauts program to involve young Americans more directly in our space program. This new organization will expand their appreciation of space as a place in which people can live, work and learn. I've asked NASA to work directly with NSI to develop this project in the context of our Private Sector Initiative Program," the President said.

Among the major new initiatives planned as part of Operation Liftoff are:

- New written materials on aeronautics and space topics for the elementary level;
- New and expanded audiovisual and computer products for classroom use;
- Encouragement of student participation in—and private sector support for—such space-and science-related extracurricular activities as the National Space Institute's new Young Astronauts youth organization;
- Establishment of strong Teacher Resource Centers at all major NASA locations, at certain university sites and at NASA Industrial Applications Centers;
- Development of prototype commercial, education and cable television programming on a pilot basis;
- Conduct of opportunities conferences for educational publishers and representatives of other organizations who can effectively utilize the materials and information in new classroom materials;
- Support for pilot programs offering one-day, space camp-type experiences for elementary students;
- Providing NASA space-related and live mission video coverage to school systems nationally;
- Encouragement of the widest possible participation by the private sector, using NASA resources wherever possible as seed money to stimulate participation by local school systems, community organizations and private businesses.

Background

According to the report of the National Commission on Excellence in Education, April 1983, the educational foundations of the United States are being eroded by a rising tide of mediocrity that threatens our future as a nation and as a people.

This erosion undergirds American prosperity and security and has permitted preeminence in commerce, industry, science and technological innovation to be overtaken by determined, well-educated and highly motivated competing nations.

Learning is a priceless investment essential to a free, democratic society. President Reagan stated: "Certainly there are few areas of American life as important to our society, to our people and to our families as our schools and colleges."

In view of a national commitment to excellence in education, the President responded with a White House-designed national program called "Partnerships in Education." He also developed the Presidential Awards for Excellence in Science and Mathematics Teaching. The first of the awards have been received by two teachers in each state.

NASA responded to the movement toward reform in education by undertaking a study of the agency's current education services to determine if services could be expanded and new directions initiated.

It was determined early in the process that if NASA's excellent educational programs were to have maximum impact on the national effort to attract more and better students into science, mathematics and engineering, it would be necessary to formulate an aggressive plan to capture their interest in their formative years, i.e., in the elementary grades. Such a program would utilize the 1,170,000 teachers and 76,302 schools currently in the elementary system, and would support and complement the widely acclaimed programs NASA now offers at university and secondary levels.

The result of this effort is Operation Liftoff.

Young Astronauts Youth Organization

The Young Astronauts Youth Organization, to be established by the National Space Institute, will be for boys and girls ages 6-12 and will be nationwide in scope. The program is designed to:

- Utilize the excitement and drama of space flight to initiate and stimulate interest on the part of young people in becoming involved, as adults, in space-related activities and careers.
- Increase student participation in technical studies such as science and math.
- Encourage appreciation of space as an environment to be explored, tamed and disciplined so that it can be used as a place in which to live, work and learn.

Young Astronauts will be an achievement-based program dedicated to developing an aspiration for excellence. Various levels of tasks will be built in which

must be achieved for students to progress through the program. Rewards, including badges, astronaut-related memorabilia and visits to space centers, will be used as incentives. The program will be school- and community-related, NASA-assisted, supported by the private sector and in operation in all 50 states within 12-24 months.

The National Space Institute is a nonprofit public interest organization founded in 1974 by space pioneer and former NASA official Dr. Wernher von Braun. NSI is engaged in a variety of educational and informational programs designed to make the public aware of the U.S. Space program.

New Publications Available

The Star Splitters: The High Energy Astronomy Observatories, NASA SP-466, has been published by NASA's Scientific and Technical Information Branch. Written by Wallace H. Tucker, an independent writer with the Harvard-Smithsonian Center for Astrophysics, the book describes the agency's HEAO program which produced major astronomical discoveries. One of the earth-orbiting satellites, HEAO-2, launched in 1978, is popularly known as the Einstein Observatory. Copies of the publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $12.00.

Astronautics and Aeronautics, 1976: A Chronology, NASA SP-4021, is the 1976 edition of the NASA History Office's annual compilation of excerpts from newspapers, magazines, speeches and government and industry announcements that document activities in the aerospace and aeronautical fields. A basic reference work for aerospace writers and historians, the publication is indexed and includes several appendices of the year's space launches and probes. Copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $9.50.

Origins of Magnetospheric Physics, a new book by space exploration pioneer James A. Van Allen, was recently published by the Smithsonian Institution Press. Researched and written during Van Allen's 1981 tenure as a regent's fellow at the National Air and Space Museum, the publication offers a close-up look at the early days of space science. The book may be purchased from the Smithsonian Institution Press, P.O. Box 1579, Washington, D.C. 20013, for $19.95. Postage and handling is $1.50 for the first copy and 50 cents for each additional copy.

What's New in NASA Television and Radio Programming

Programs released in June:

Television

Aeronautics & Space Report (4½ and 90 minute versions):

Space Shuttle . . . The 12th Flight

Radio

Space Story (4½-minute programs):

The 12th Space Shuttle Mission (featuring Astronaut Judith Resnik)

Solar Array (featuring Robert McAnnally, Marshall Space Flight Center)

The Large Format Camera (featuring Bruton Schardt, NASA Headquarters)

Space Tomatoes (featuring Dr. Doris Grigsby, NASA Headquarters)

Special Report (14½-minute program):

The 12th Space Shuttle Mission (featuring the 41-D crew: Henry Hartsfield, Michael Coats, Judith Resnik, Steven Hawley and Charles Walker)

Copies of television tapes are sent simultaneously to all NASA Visitor Information Centers and Public Affairs Offices, and to 650 television stations nationwide as well as to 425 cable television systems via the satellite RCA-Cablenet 1. Five hundred television stations receive material formatted as a 4½-minute program; the remaining 150 stations receive a 90-second "spot" — a condensed version of the 4½-minute presentation.

NASA's radio programs are sent to approximately 3,000 radio stations across the nation; in addition, translations of the recordings are made by Voice of America and Radio Free Europe and these tapes are then released to the appropriate audiences overseas. Released each month are one report of 14½ minutes and four 4½-minute weekly stories (one story in the set is featured for one week of the month). Ten one-minute space notes are released quarterly.

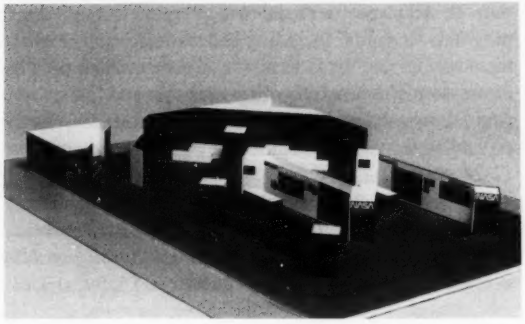
NASA To Participate In 32nd Annual EAA Convention and Sport Aviation Exhibition

NASA will be one of the chief exhibitors and technical participants at the 32nd Annual Experimental Aircraft Association Convention and Sport Aviation Exhibition, July 28 through Aug. 4, in Oshkosh, Wis.

Speakers and displays from the agency's three aeronautical centers—Ames Research Center, Mountain View, Calif., which specializes in flight testing; Langley Research Center, Hampton, Va., which emphasizes aerodynamic technology; and Lewis Research Center, Cleveland, Ohio, NASA's lead aeropropulsion facility—will focus on the theme: "Research Enhances Aviation Safety and Performance." There also will be speakers from Goddard Space Flight Center, Greenbelt, Md., and Wallops Flight Facility, Wallops Island, Va.

A large exhibition will present technical exhibits by NASA divided into four general categories: Aerodynamics, Propulsion, Structures and Operations/Human Factors. Aerodynamics exhibits will feature research in the areas of aircraft performance, stability and control, and configuration. Propulsion exhibits will cover engine, propeller and other propulsion research. Exhibits relating to structures research will present new materials research and testing for crashworthiness. Avionics, flight simulation and new information about flying in adverse weather conditions are among the topics to be presented in the Operations/Human Factors exhibits. An exhibit on the Search and Rescue Satellite (SARSAT) will also be featured.

The NASA exhibition area will also include a small theater which will offer audiovisual presentations as well as special public lectures on aerospace topics.



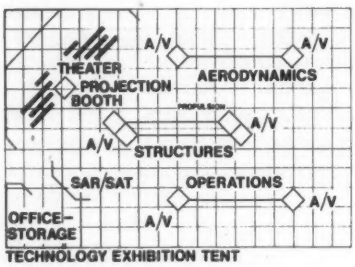
Birdseye view of interior (tent removed) of NASA Technology Exhibition at Oshkosh; below, layout of NASA Plaza.

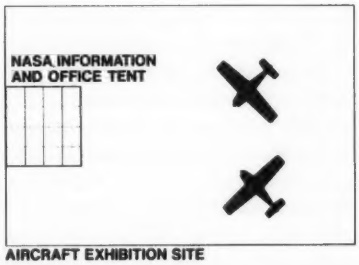
NASA's AEROVAN, a large, walk-through traveling exhibit unit which tells the story of the first "A" in NASA—aeronautics—will also be featured.

At the nearby EAA museum, NASA will sponsor a hands-on exhibit featuring a real-time information system for cockpit display.

In addition to high technology displays, NASA hopes to have flight research aircraft on static display during the convention.

The EAA's annual International Fly-In Convention and Sport Aviation Exhibition attracted approximately 800,000 participants last year. NASA has participated in the annual convention for more than a decade.





NASA OSHKOSH - 84 SITE PLAN

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent Office and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
H. Douglas Garner, William E. Howell, NASA/LaRC	Heads up display	4,453,163	LaRC
J.D. Whittenberger, Francis I. Hurwitz, NASA/LeRC	Method and apparatus for gripping uniaxial fibrous materials	4,452,088	LeRC
George L. Von Pragenau, NASA/MSFC	Space Shuttle with rail system and aft thrust structure securing solid rocket boosters to external tank	4,452,412	MSFC
Richard W. Lauver, NASA/LeRC	Chemical approach for controlling nadimide cure temperature and rate	4,455,418	LeRC
Vinod Jalan, Margared A. Reid, Jo Ann Charleston, NASA/LeRC	Chromium electrodes for redox cells	4,454,649	LeRC
Salvador Villarreal, Stuart D. Lenett, Herbert S. Kobayashi, James F. Pawlowski, NASA/JSC	Method and apparatus for receiving and tracking phase modulated signals	4,455,680	JSC
Don A. Gregory, Charles D. Stocks, NASA/MSFC	Apparatus for measuring charged particle beam	4,455,532	MSFC
Richard P. Tschirch, Kenneth R. Sidman, Irving J. Arons, Arthur D. Little, Inc., Cambridge, Mass.	Heat resistant protective hand covering	4,454,611	JSC
Kenneth E. Riggs, Carl J. Wojciechowski, Lockheed Missiles & Space Co., Huntsville, Ala.	Diffuser/ejector system for a very high vacuum environment	4,454,753	MSFC
Ian O. Macconochie, Ashby G. Lawson, H. Neale Kelly, NASA/LaRC	Shell tile thermal protection system	4,456,208	LaRC

Auto Technology Feasible for Aircraft Applications

A 50 percent cut in fuel consumption and increased fuel flexibility may be achieved, by applying technology derived from automotive gas turbine research to general aviation aircraft propulsion systems, according to a study by NASA's Lewis Research Center in Cleveland.

Known as the Regenerative Intercooled Turbine Engine (RITE) Program, the concept under investigation featured uncooled ceramic turbines, a regenerator to capture otherwise wasted heat from the engine's exhaust and an intercooler to reduce the work load on the engine's air compressor.

These devices would allow the engine to operate more efficiently, specifically at about half the fuel consumption of a current conventional aircraft turbine engine with the same power rating. That rating, for application in a pressurized twin-engine six-place turboprop aircraft, would be in the 500-shp (shaft horsepower) range at takeoff for a 25,000 foot cruise altitude. The RITE concept also would permit the use of a wide range of kerosene-based fuels, increasing fuel flexibility and eliminating general aviation dependence on aviation gasoline.

Adding to the interest in the research effort, according to Lewis project manager Gerald Knip, were recent advances in the development of high-temperature ceramics for automotive gas turbine applications, many of which originated at Lewis. The study concluded that high cycle temperatures obtainable with ceramic components coupled with an efficient heat recovery device provide the potential for a highly efficient aircraft engine.

"A major emphasis of further work on the engine concept is to upgrade reliability of the ceramic components. Power loss in an aircraft engine obviously is a lot more serious than power loss in an automobile," says Knip.

Log of Apollo 11

July 16, 1969

9:32 a.m. EDT — On schedule to within less than a second, Apollo 11 blasts off from Launch Pad 39A at Cape Kennedy, Fla., to start what is looked upon as a milestone event in human history — a trip to the moon, a manned landing and return to earth.

Watching is a world-wide television audience and an estimated million eyewitnesses. Standing 3½ miles away on the sandflats or seated in grandstands are half the members of the U.S. Congress and more than 3,000 newsmen from 56 countries.

Strapped to their couches in the command module atop the 363-foot, 7.6-million-pound thrust space vehicle are three astronauts, each born in 1930, each weighing 165 pounds, all within an inch of the same height — 5 ft. 11 inches. They are Commander Neil A. Armstrong, civilian and ex-test pilot; Command Module Pilot Michael Collins, and Lunar Module Pilot Edwin E. (Buzz) Aldrin Jr., the latter two, officers of the U.S. Air Force.

The launch comes after a 28-hour countdown. It takes place in highly suitable weather, with winds 10 knots from the southeast, temperature in the mid-80s, and clouds at 15,000 feet.

At 4:15 a.m., the astronauts had been awakened. After a breakfast of orange juice, steak, scrambled eggs, toast and coffee, they began suiting up at 5:35 a.m. At 6:27 a.m., they left in an air-conditioned van for the launch pad eight miles away. At 6:54 a.m., Armstrong entered the command module and took position on the left. He was followed five minutes later by Collins, on the right, and Aldrin, in the center.

Two minor problems that developed in the ground equipment, a leaky valve and a faulty signal light, were corrected while the astronauts were en route to the pad.

The Apollo access arm retracted at 9:27 a.m. Eight and nine-tenths seconds before launch time, the first of the Saturn V's first stage engines ignited. From the viewing stands, the flame appeared as a bright yellow-orange star on the horizon. Soon the other four engines fired and the light of the first engine became a huge fireball that lit the scene like a rising sun. No sound was heard. For two seconds the vehicle built up thrust. The hold down clamps were released and the space vehicle began moving slowly upward from the pad, as near 9:32 a.m. as human effort could make it.

As it reached the top of the service tower, the hard-edged clattering thunder of the firing engines rolled over the scrubby Florida landscape and engulfed the viewers like a tidal wave. They witnessed the beginning of the fifth manned Apollo flight, the third to the vicinity of the Moon and the first lunar landing mission.

From launch Control the last words were: "Good luck and Godspeed." Commander Armstrong replied, "Thank you very much. We know this will be a good flight."

9:35 a.m. — The spacecraft is 37 nautical miles high, downrange 61 nautical miles and traveling at 9,300 feet per second or about 6,340 miles per hour. Armstrong confirms the engine skirt and launch escape tower separations.

9:44 a.m. — With the three Saturn stages fired one after another and the first two jettisoned, Apollo 11 enters a 103 nautical mile-high earth orbit, during which the vehicle is carefully checked by the astronauts and by the ground control crew.

12:22 p.m. — Another firing of the third-stage engine, still attached to the command service module, boosts Apollo 11 out of orbit midway in its second trip around the earth and onto its lunar trajectory at an initial speed of 24,200 miles an hour.

12:49 p.m. — While the spacecraft moves farther and farther from earth, the lunar landing craft, Eagle, is unpacked from its compartment atop the launch rockets. The astronauts first fire some explosive bolts. These cause the main spacecraft, Columbia, to separate from the adapter and blow apart the four panels that make up its sides, exposing the lunar module (LM) tucked inside. They stop the spacecraft about 100 feet away — 34 feet farther than they were supposed to — turn the ship around, facing the landing craft, and dock head-to-head with it. The docking complete, the LM's connections with the adapter are blown loose and the mated

command/service and lunar modules separate from the rocket and continue alone toward the moon.

2:38 p.m. — By dumping its leftover fuel the third rocket stage is fired into a long solar orbit to remove it from Apollo 11's path.

2:43 p.m. — With the flight on schedule and proceeding satisfactorily, the first scheduled midcourse correction is considered unnecessary.

2:54 p.m. — The spacecraft is reported 22,000 nautical miles from earth and traveling at 12,914 feet per second. Crew members keep busy with housekeeping duties.

8:52 p.m. — Mission Control at Houston, Texas, says good night to the crew as they prepare to go to sleep two hours early.

10:59 p.m. — Because of the pull of earth's gravity, the spacecraft has slowed to 7,279 feet per second at a distance of 63,880 nautical miles from earth.

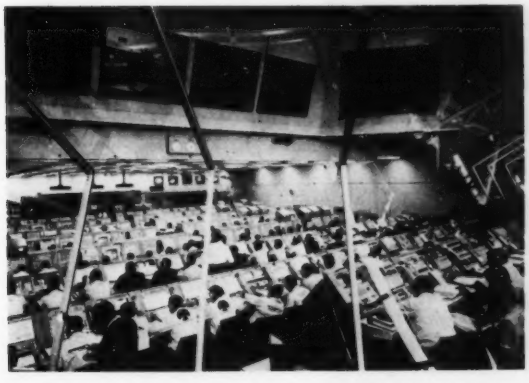
July 17

8:48 a.m. — Mission Control gives Apollo crew a brief review of the morning news, including sports developments. They are informed about the progress of the Russian space ship Lunar 15 and that Vice President Spiro T. Agnew, ranking government official at the Apollo 11 blastoff, has called for putting a man on Mars by the year 2000.

12:17 p.m. — Midcourse correction is made with a three-second burn, sharpening the course of the spacecraft and testing the engine that must get them in and out of lunar orbit.

7:31 p.m. — Astronauts begin first scheduled color telecast from spacecraft, showing view of the earth from a distance of about 128,000 nautical miles. During the 36-minute transmission, views are also shown of the inside of the command module.

9:42 p.m. — Mission control bids the crew goodnight.



Engineers in the Launch Control Center monitor the liftoff of Apollo 11.

July 18

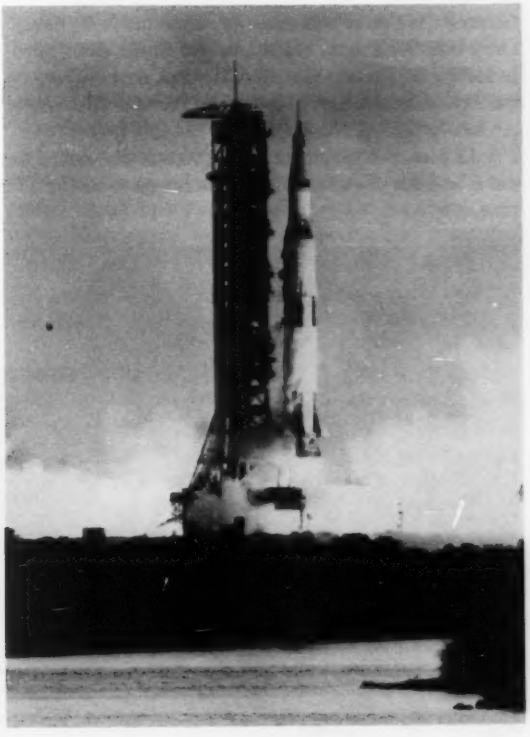
9:41 a.m. — Mission Control lets astronauts sleep an hour later than scheduled on the third day of the outward journey. After breakfast, they begin housekeeping chores, such as charging batteries, dumping waste water, and checking fuel and oxygen reserves. Announcement is made to them that course corrections scheduled for afternoon will not be necessary.

2:57 p.m. — Astronauts are given report on day's news.

4:40 p.m. — One of the clearest television transmissions ever sent from space is begun, with the spacecraft 175,000 nautical miles from earth and 48,000 from the moon. It lasts an hour and 36 minutes. While in progress, the hatch to the LM is opened and Armstrong squeezes through the 30-inch-wide tunnel to inspect it. He is followed by Aldrin.

10:00 p.m. — Mission Control tells the crew goodnight.

11:12 p.m. — Velocity of spacecraft has slowed to 2,990 ft. per second just before entering the moon's sphere of influence at a point 33,823 nautical miles away from it.



LIBRARY
EASTERN MICHIGAN UNIVERSITY
YPSILANTI
U. S. DEPOSITORY DOCUMENT

July 19

6:58 a.m. — Astronauts call Mission Control to inquire about scheduled course correction and are told it has been cancelled. They are also advised they may go back to sleep.

8:32 a.m. — Mission Control signals to arouse crew and to start them on breakfast and housekeeping chores.

10:01 a.m. — Astronauts are given review of day's news and are told of worldwide interest in moon mission.

10:31 a.m. — Collins reports: "Houston, it's been a real change for us. Now we are able to see stars again and recognize constellations for the first time on the trip. The sky is full of stars, just like the nights on Earth. But all the way here we have just been able to see stars occasionally and perhaps through monoculars, but not recognize any star pattern."

10:42 a.m. — Armstrong announces: "The view of the moon that we've been having recently is really spectacular. It fills about three-quarters of the hatch window and, of course, we can see the entire circumference, even though part of it is in complete shadow and part of it's in earth-shine. It's a view worth the price of the trip."

12:58 p.m. — The crew is informed by Mission Control: "We're 23 minutes away from the LOI (Lunar Orbit Insertion) burn. Flight Director Cliff Charlesworth is polling flight controllers for its status now." Then quickly, seconds later: "You are go for LOI." Aldrin replies: "Roger, go for LOI."

1:13 p.m. — Spacecraft passes completely behind the moon and out of radio contact with the earth for the first time.

1:28 p.m. — The spacecraft's main rocket, a 20,500-pound-thrust engine, is fired for about six minutes to slow the vehicle so that it can be captured by lunar gravity. It is still behind the moon. The resulting orbit ranges from a low of 61.3 nautical miles to a high of 168.8 nautical miles.

1:55 p.m. — Armstrong tells Mission Control: "We're getting this first view of the landing approach. This time we are going over the Taruntius crater and the pictures and maps brought back by Apollos 8 and 10 give us a very good preview of what to look at here. It looks very much like the pictures, but like the difference between watching a real football game and watching it on TV — no substitute for actually being here."

About 15 minutes later he adds: "It gets to be a lighter gray, and as you get closer to the subsolar point, you can definitely see browns and tans on the ground."

And a few moments still later: "When a star sets up here, there's no doubt about it. One instant it's there and the next instant it's just completely gone."

3:56 p.m. — A 35-minute telecast of the moon's surface begins. Passing westward along the eastern edge of the moon's visible side, the camera is focused especially on the area chosen as a landing site.

5:44 p.m. — A second burn of the spacecraft's main engine, this one for 17 seconds, is employed while the spacecraft is on the back side of the moon to stabilize the orbit at about 54 by 66 nautical miles.

6:57 p.m. — Armstrong and Aldrin crawl through the tunnel into the lunar module to give it another check. The spacecraft is orbiting the moon every two hours.

This view of the rising earth greeted the Apollo 11 astronauts as they came from behind the moon after the lunar orbit insertion burn.

July 20

9:27 a.m. — Aldrin crawls into the lunar module and starts to power-up the spacecraft. About an hour later, Armstrong enters the LM and together they continue to check the systems and deploy the landing legs.

1:46 p.m. — The landing craft is separated from the command module, in which Collins continues to orbit the moon.

2:12 p.m. — Collins fires the command ship's rockets and moves about two miles away.

3:08 p.m. — Armstrong and Aldrin, flying feet first and face down, fire the landing craft's descent engine for the first time.

3:47 p.m. — Collins, flying the command ship from behind the Moon, reports to earth that the landing craft is on its way down to the lunar surface. It is the first Mission Control has heard of the action. "Everything's going just swimmingly. Beautiful!" Collins reports.

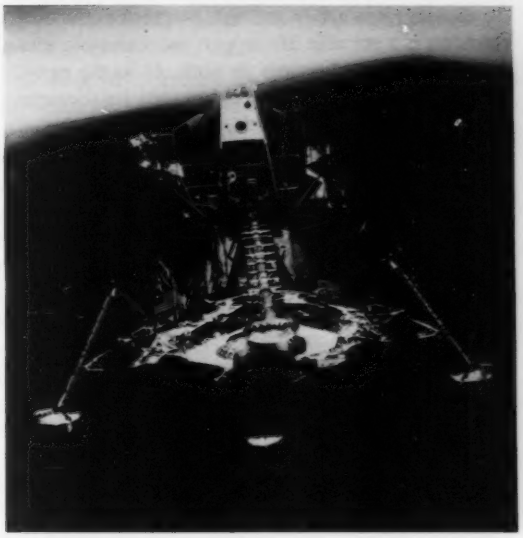
4:05 p.m. — Armstrong throttles up the engine to slow the LM before dropping down on the lunar surface. The landing is not easy. The site they approach is four miles from the target point, on the southwestern edge of the Sea of Tranquility. Seeing that they are approaching a crater about the size of a football field and covered with large rocks, Armstrong takes over manual control and steers the craft to a smoother spot. His heartbeat has risen from a normal 77 to 156.

While Armstrong flies the landing craft, Aldrin gives him altitude readings: "Seven hundred and fifty feet, coming down at 23 degrees . . . 700 feet, 21 down . . . 400 feet, down at nine . . . Got the shadow out there . . . 75 feet, things looking good . . . Lights on . . . Picking up some dust . . . 30 feet, 2½ down . . . Faint shadow . . . Four forward. Four forward, drifting to the right a little . . . Contact light. Okay, engine stop."

When the 68-inch probes beneath three of the spacecraft's four footpads touch down, flashing a light on the instrument panel, Armstrong shuts off the ship's engine.

4:18 p.m. — The craft settles down with a jolt almost like that of a jet landing on a runway. It is at an angle of no more than four or five degrees on the right side of the moon as seen from earth. Armstrong immediately radios Mission Control: **"The Eagle has landed."**

Aldrin, looking out of the LM window, reports: "We'll get to the details around here, but it looks like a collection of just every variety of shapes, angularities and granularities, every variety of rock you could find. The colors vary pretty much depending on how you're looking. . . . There doesn't appear to be much of a general color at all; however, it looks as though some of the rocks and boulders, of which there are quite a few in the near area . . . are going to have some interesting colors to them."



The Lunar Module, carrying Armstrong and Aldrin, is photographed by Collins as it moves away after separation from the Command Module.

A few moments later he tells of seeing numbers of craters, some of them 100 feet across, but the largest number only one or two feet in diameter. He sees ridges 20 or 30 feet high, two-foot blocks with angular edges, and a hill half a mile to a mile away.

Finally, in describing the surface, Aldrin says: "It's pretty much without color. It's gray and it's a very white, chalky gray, as you look into the zero phase line, and it's considerably darker gray, more like ashen gray as you look up 90 degrees to the Sun. Some of the surface rocks close in here that have been fractured or disturbed by the rocket engine are coated with this light gray on the outside, but when they've been broken they display a dark, very dark gray interior, and it looks like it could be country basalt."

The first task after landing is that of preparing the ship for launching, of seeing that all is in readiness to make the ascent back to a rendezvous with the command spacecraft orbiting above.

6:00 p.m. — With everything in order, Armstrong radios a recommendation that they plan to start the EVA (extravehicular Activity), earlier than originally scheduled, at about 9:00 p.m. EDT. Mission Control replies: "We will support you anytime."

10:39 p.m. — Later than proposed at 6:00 p.m., but more than five hours ahead of the original schedule, Armstrong opens the LM hatch and squeezes through

the opening. It is a slow process. Strapped to his shoulders is a portable life support and communications system weighing 84 pounds on earth, 14 on the moon, with provision for pressurization; oxygen requirements and removal of carbon dioxide.

Armstrong moves slowly down the 10-foot, nine-step ladder. On reaching the second step, he pulls a "D-ring," within easy reach, deploying a television camera, so arranged on the LM that it will depict him to earth as he proceeds from that point.

Down the ladder he moves and halts on the last step. "I'm at the foot of the ladder," he reports. "The LM footpads are only depressed in the surface about one or two inches . . . the surface appears to be very, very finegrained, as you get close to it, it's almost like a powder."

10:56 p.m. — Armstrong puts his left foot to the Moon. It is the first time in history that man has ever stepped on anything that has not existed on or originated from the Earth.

"That's one small step for a man, one giant leap for mankind," Armstrong radios. Aldrin is taking photographs from inside the spacecraft.

The first print made by the weight of man on the Moon is that of a lunar boot which resembles an oversized galosh. Its soles are of silicon rubber and its 14-layer sidewalls of aluminized plastic. Specially designed for super-insulation, it protects against abrasion and has reduced friction to facilitate donning. On earth, it weighs four pounds, nine ounces; on the moon, 12 ounces.

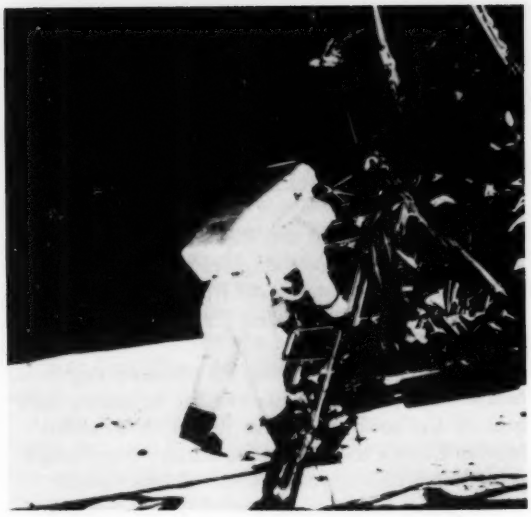
Armstrong surveys his surroundings for a while and then moves out, testing himself in a gravity environment one-sixth of that on earth. "The surface is fine and powdery," he says. "I can pick it up loosely with my toe. It does adhere in fine layers like powdered charcoal to the sole and sides of my boots. I only go in a small fraction of an inch. Maybe an eighth of an inch, but I can see the footprints of my boots and the treads in the fine sandy particles.

"There seems to be no difficulty in moving around as we suspected. It's even perhaps easier than the simulations. . . ."

Feeling more confident, Armstrong begins making a preliminary collection of soil samples close to the landing craft. This is done with a bag on the end of a pole.

"This is very interesting," he comments. "It's a very soft surface, but here and there . . . I run into a very hard surface, but it appears to be very cohesive material of the same sort. . . . It has a stark beauty all its own. It's like much of the high desert of the United States."

He collects a small bagful of soil and stores it in a pocket of the left leg of his space suit. This is done early, according to plan, to make sure some of the moon surface is returned to earth in case the mission has to be cut short.

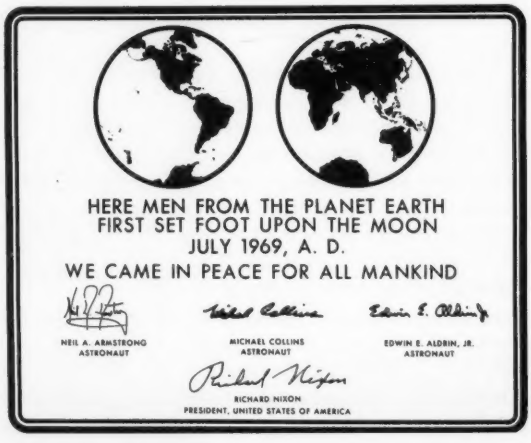


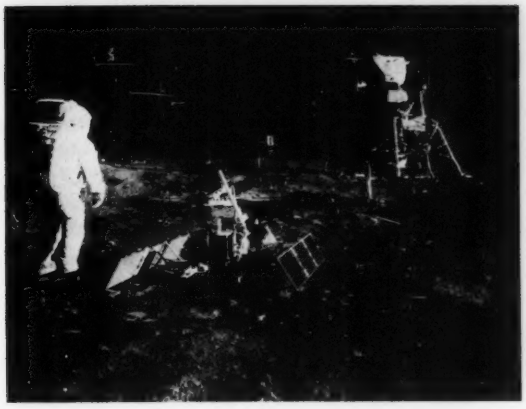
Aldrin makes his descent down the Lunar Module ladder.

11:11 p.m. — After lowering a Hasselblad still camera to Armstrong, Aldrin emerges from the landing craft and backs down the ladder, while his companion photographs him.

"These rocks . . . are rather slippery," Armstrong says. The astronauts report that the powdery surface seems to fill up the fine pores of the rocks, and they tend to slide over them rather easily.

Armstrong fits a long focal length lens into position on the TV camera and trains it upon a small, stainless steel plaque on one of the legs of the landing craft. He



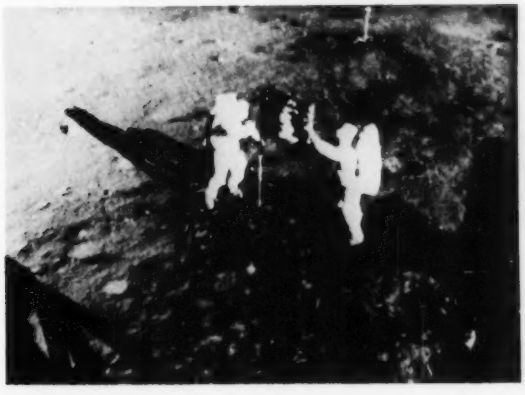


Aldrin deploys the Passive Seismic Experiments Package; below, Armstrong (left) and Aldrin place the flag of the United States on the moon's surface.

reads: "Here men from the planet earth first set foot on the moon. July 1969 A.D. We came in peace for all mankind." Below the inscription are the names of the Apollo crew and President Nixon.

Armstrong next removes the TV camera from its fixed position on the LM and moves it away about 40 feet so it can cover the area in which the astronauts will operate.

As scheduled, the astronauts set up the first of three experiments. From an outside storage compartment in the LM, Aldrin removes a foot-long tube containing a roll of aluminum foil. Inside the roll is a telescoped pole that is driven into the lunar surface, after which the foil is suspended from it, with side marked "sun" next to the sun. Its function will be to collect the particles of "solar wind" blowing constantly through space so that they can be brought back and analyzed in the hope they will provide information on how the sun and planets were formed.



11:41 p.m. — From a leg of the spacecraft, the astronauts take a three-by-five-foot, nylon U.S. flag, its top edge braced by a spring wire to keep it extended on the windless moon and erect it on a staff pressed into the lunar surface.

Taken to the moon are two other U.S. flags, to be brought back and flown over the houses of Congress, the flags of the 50 States, the District of Columbia and U.S. territories, and United Nations flag, as well as those of 136 foreign countries.

11:47 p.m. — Mission Control announces: "The President of the United States is in his office now and would like to say a few words to you." Armstrong replies: "That would be an honor."

11:48 p.m. — The astronauts listen as the President speaks by telephone: "Neil and Buzz. I am talking to you from the Oval Room at the White House. And this certainly has to be the most historic telephone call ever made. . . . For every American this has to be the proudest day of our lives. And for people all over the world I am sure they, too, join with Americans in recognizing what a feat this is. Because of what you have done, the heavens have become a part of man's world. As you talk to us from the Sea of Tranquility, it inspires us to redouble our efforts to bring peace and tranquility to earth. For one priceless moment, in the whole history of man, all the people on this earth are truly one."

As the President finishes speaking, Armstrong replies: "Thank you, Mr. President. It's a great honor and privilege for us to be here representing not only the United States but men of peace of all nations. And with interest and a curiosity and a vision for the future. It's an honor for us to be able to participate here today."

The two astronauts stand at attention, saluting directly toward the television as the telephone conversation concludes.

Armstrong next sets up a folding table and opens on it two specimen boxes. Using tongs and the lunar scoop, a quantity of rocks and soil are picked up and sealed in the boxes, preparatory to placing them in the ascent stage of the landing craft.

Aldrin, meanwhile, opens another compartment in the ship and removes two devices to be left on the moon, taking each out about 30 feet from the ship. One is a seismic detector, to record moonquakes, meteorite impact, or volcanic eruption, and the other a laser-reflector, a device designed to make a much more precise measurement of earth-moon distances than has ever been possible before.

As Aldrin walks on the moon's surface, the Lunar Module is reflected in his space helmet visor.

July 21

12:54 a.m. — After checking with Mission Control to make sure all chores have been completed, experiments set up, and photographs taken, Aldrin starts back up the ladder to re-enter the LM.

1:09 a.m. — Armstrong joins Aldrin in the landing craft.

1:11 a.m. — The hatch is closed. The astronauts begin removing the portable life support systems on which they have depended for two hours and 47 minutes.

4:25 a.m. — Astronauts are told to go to sleep, after attending to final housekeeping details and answering a number of questions concerning the geology of the moon.

9:44 a.m. — Shortly after arousing Collins, still circling the moon in the Command/Service Module, Mission Control observes: "Not since Adam has any human known such solitude as Mike Collins is experiencing during this 47 minutes of each lunar revolution when he's behind the moon with no one to talk to except his tape recorder aboard Columbia."

11:13 a.m. — The astronauts in Eagle are aroused. Aldrin announces: "Neil has rigged himself a really good hammock . . . and he's been lying on the hatch and engine cover, and I curled up on the floor."

12:42 p.m. — Answering a question raised before they went to sleep, Aldrin reports: "We are in a boulder field where boulders range generally up to two feet, with a few larger than that. . . . Some of the boulders are lying on top of the surface, some are partially exposed, and some are just barely exposed."

1:54 p.m. — Ascent engine is started and LM, using descent stage as a launch pad, begins rising and reaches a vertical speed of 80 feet per second at 1,000 feet altitude.

The astronauts take with them in the ascent stage the soil samples, the aluminum foil with the "solar wind" particles it has collected, the film used in taking photographs with still and motion picture cameras, the flags and other mementos to be returned to earth. Behind they leave a number of items, reducing the weight of the ship from 15,897 pounds as it landed on the moon to 10,821 pounds.

The largest item left behind is the descent stage, that part of the landing craft with the plaque on one of its spidery legs. Others include the TV camera, two still cameras, tools used in collecting samples, portable life support systems, lunar boots, American flag, rod support for the "solar wind" experiment instrument, laser beam reflector, seismic detector, and a gnomon, a device to verify colors of objects photographed.

5:35 p.m. — Eagle redocks with Columbia while circling on the back side of the moon.

7:42 p.m. — The landing craft is jettisoned.

July 22

12:56 a.m. — While on the back side of the moon, with the LM 20 miles behind the CSM, the transearth injection burn of Apollo 11 is begun, with the spacecraft traveling at 5,329 feet per second at an altitude of about 60 nautical miles.

4:30 a.m. — Astronauts start sleep period.

1:00 p.m. — Astronauts begin waking for first full day of return trip.

1:39 p.m. — Spacecraft passes point in space, 33,800 nautical miles from the moon and 174,000 from the earth, where the earth's gravity takes over and

begins drawing the astronauts homeward.

4:02 p.m. — Midcourse correction is made to readjust the flight path of the spacecraft.

9:08 p.m. — Eighteen minutes of live TV transmission to earth begins.

July 23

2:14 a.m. — Crew starts sleep period.

12:20 p.m. — Crew awakens. Begins relaxed checking of systems and conversation with Mission Control.

3:56 p.m. — Spacecraft passes midway point of journey homeward, 101,000 nautical miles from splashdown.

7:03 p.m. — Final color television transmission begins.

July 24

6:47 a.m. — Crew awakens and begins to prepare for splashdown.

12:21 p.m. — Command and service modules are separated.

12:35 p.m. — Command module reenters the earth's atmosphere.

12:51 p.m. — Spacecraft splashes down 825 nautical miles southwest of Honolulu and about 13 nautical miles from the recovery ship, the U.S.S. Hornet.

1:20 p.m. — Hatch of command module opens and frogman hands in isolation suits.

1:28 p.m. — Astronauts emerge from the spacecraft in isolation suits and are sprayed with a disinfectant as a guard against the possibility of their contaminating the earth with moon "germs."

Apollo 11 astronauts are recovered in the Pacific Ocean 900 miles southwest of Hawaii.

From the left, Armstrong, Collins and Aldrin smile through the window of the Mobile Quarantine Facility aboard the USS Hornet at the completion of their historical lunar landing mission.

1:57 p.m. — Astronauts arrive by helicopter on the flight deck of the Hornet. Still inside the helicopter they ride an elevator to hangar deck and then walk immediately into the mobile quarantine trailer in which they will remain until they arrive at the Lunar Receiving Laboratory at Houston early July 27.

3:00 p.m. — President Nixon welcomes the astronauts, visible through a window of the trailer. Speaking over an intercom, he greets them, extends them an invitation to attend a dinner with him Aug. 13, and tells them:

"This is the greatest week in the history of the world since the Creation. . . . As a result of what you have done, the world's never been closer together. . . . We can reach for the stars just as you have reached so far for the stars."

3:55 p.m. — The command module arrives on board the Hornet, after traveling 952,700 nautical miles since July 16.

So ends man's first mission to the moon. It has lasted 195 hours, 18 minutes and 35 seconds or a little more than eight days. It is recognized as the most trouble-free mission to date, almost completely on schedule and successful in every respect.

Crew Members Named for Future Space Shuttle Flights

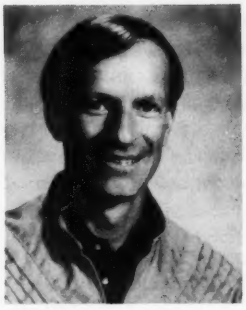
NASA has announced the flight crew for Space Shuttle flight 51-H and mission specialist astronauts for mission 61-E.

Veteran astronaut Vance D. Brand will command mission 51-H, scheduled for launch in November 1985, using the orbiter Atlantis. Brand was commander of STS-5, the first operational Shuttle flight in November 1982 and mission 41-B, the first use of the manned maneuvering unit in February 1984.

Other members of the 51-H crew are Michael J. Smith, pilot; Robert C. Springer, Dr. Owen K. Garriott and European Space Agency astronaut, Dr. Claude Nicollier, mission specialists; and Dr. Michael L. Lampton and Dr. Byron K. Lichtenberg, payload specialists, who were named earlier to the crew.

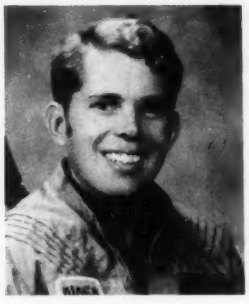
Payload on Flight 51-H will be Earth Observation Mission-1 (EOM-1), a reflight of nine Spacelab-1 experiments in the areas of space plasma physics, solar physics, atmospheric physics, astronomy and earth observations. A short Spacelab habitable module and a pallet of experiment hardware will occupy the cargo bay.

Launch of 61-E is set for March 1986, with a crew of six on the orbiter Columbia. Mission specialists for the mission include Dr. Robert A. R. Parker, David C. Leestma and Dr. Jeffrey A. Hoffman. The cargo will be Intelsat VI-1, a large communications satellite for Intelsat, the multinational communications satellite network, and Astro-1, an astronomy package designed to view Halley's Comet.

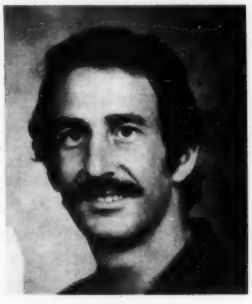


Claude Nicollier

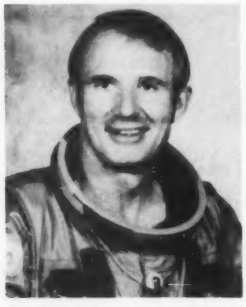
Robert A.R. Parker



David C. Leestma

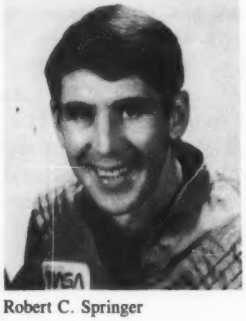


Jeffrey A. Hoffman



Vance D. Brand

Michael J. Smith



Robert C. Springer

Owen K. Garriott

Crew Member Added To Shuttle Mission 41-G

Paul D. Scully-Power, 40, a civilian oceanographer with the U.S. Navy has been added to the 41-G Space Shuttle crew that is scheduled to fly in October. He joins Robert L. Crippen, commander; Jon A. McBride, pilot; mission specialists Dr. Kathryn D. Sullivan, Dr. Sally K. Ride, David D. Leestma; and payload specialist Dr. Marc D. Garneau of Canada.

The 57 degree inclination orbit will provide a unique opportunity for a trained scientist to view over three-fourths of the earth's oceans from space. The data collected will add extensively to NASA's and the Navy's oceanographic studies programs.

The addition of Scully-Power as a payload specialist makes the 41-G crew the largest for a Shuttle mission to date, seven.

Scully-Power has played a major role in NASA's oceanographic program for more than three years. He has participated in briefings before and debriefings after each Shuttle flight and has had extensive experience in the analysis of imagery taken not only from the Shuttle but also from the Gemini and Skylab programs. The objective of flying an oceanographer with such experience is expected to result in more effective use of the Shuttle for ocean related missions.

Scully-Power has spent extensive time in oceanographic studies. He has participated in 24 scientific cruises, 13 for which he was Chief Scientist, and he is a qualified Navy diver.

Scully-Power has published over 60 scientific articles in such fields as oceanography, underwater acoustics, remote sensing, applied mathematics, space oceanography, marine biology, meteorology and ocean engineering.

The major purposes of mission 41-G are deployment of the Earth Radiation Budget Satellite (ERBS), operation of the Shuttle Radar Laboratory—Office of Space Science and Terrestrial Applications-3 (OSTA-3)—and operation of the Large Format Camera.

The Shuttle Radar Laboratory is an upgraded reflight of the successful Shuttle Imaging Radar (SIR-A) that flew on STS-2. Also on this mission, the Orbital Reservicing System (ORS) will be demonstrated. The ORS requires extravehicular activity by Sullivan.

Consistent with NASA policy, the data gathered by Scully-Power will be made available to the public for scientific and educational purposes.

NASA Works To Improve Aerial Application of Chemicals

NASA research may contribute to more efficient methods for aerial application of insecticides and herbicides.

The agency has conducted basic research in aerodynamics relating to aerial applications since 1976, when chemical drift from target areas was identified as the aerial application industry's most important technical concern because of increasing chemical costs and environmental factors.

Control of chemical drift is a complex problem requiring an understanding of many factors, including airplane wake aerodynamics. Researchers at NASA's Langley Research Center, Hampton, Va., have worked to improve the integration of airplane wake characteristics with dispersal equipment to produce wider, more uniform application patterns for liquid or solid agricultural chemicals released in the wakes of airplanes or helicopters with minimum losses due to chemical drift.

To accomplish this, a computer program or code was developed, tested and made available to interested U.S. agricultural aircraft or equipment designers and operators. The code, dubbed AGDISP (for AGricultural DISPersal), accounts for the effects of atmospheric turbulence, crosswind, propeller slipstream, terrain variations, droplet evaporation and plant canopy density on particle trajectories. Development of AGDISP was jointly funded by the U.S. Department of Agriculture's Forest Service and NASA. It is the first spray prediction technique that incorporates both atmospheric and aircraft aerodynamic properties and, therefore, offers greatly improved accuracy.

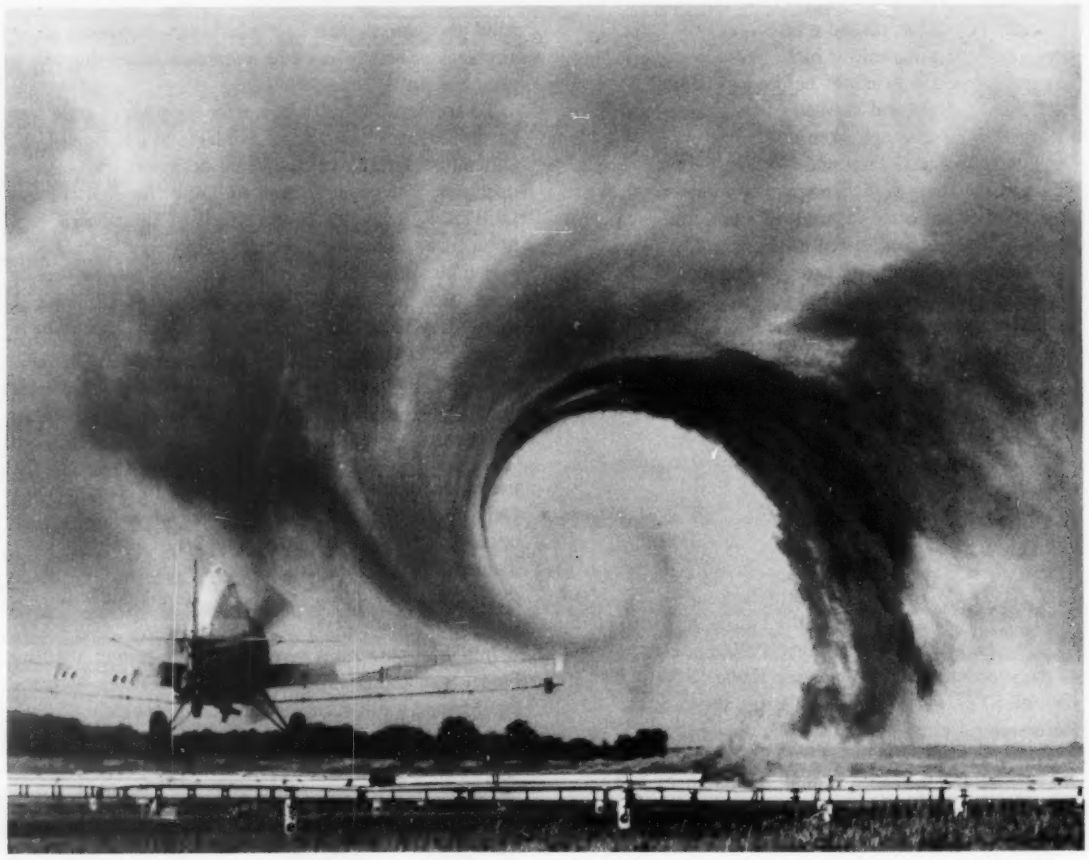
Despite its complexity, the code is quick and easy to use by operators without a background in aerodynamics. Only information readily available to the aircraft operator is needed, such as engine RPM and propeller diameter. One computer software company is making the code available in a "language" compatible with many home computers.

Initial investigations involved ground testing a scale model agricultural airplane in Langley's Wake Vortex Facility and a full-scale airplane in the center's 30-by-60-Foot Wind Tunnel. "These tests," explains Dana Morris, an engineer in Langley's Low-Speed Aerodynamics Division, "showed us we could alter the airplane wake and measure the impact of the spray deposition pattern."

Then experimental flights were conducted at NASA's Wallops Flight Facility, Wallops Island, Va. In the tests, an Ayres Thrush S2R-800 agricultural airplane (loaned without charge by the Ayres Corp., Albany, Ga.) was flown low over three long rows of adhesive strips, 50 feet apart, and solid particles were released to simulate spray droplets. The tests provided wake interaction data showing the influences of atmospheric and airplane operating conditions on spray patterns. These data were then correlated with computer predictions.

Comparison of AGDISP computer predictions with experimental data from the flight tests shows generally good agreement, prompting Dr. Bruce J. Holmes, Langley's aerial applications program manager, to conclude that preliminary analysis of aircraft configurations and dispersal systems can now be made without costly flight tests for each aircraft and nozzle system.

The experimental work provides examples of using the computer code for two different types of analysis, explains Morris: "First, the code will be applied to the



The air flow from the wing of an agricultural airplane is made visible by a technique that uses colored smoke rising from the ground. The swirl at the wing tip traces the airplane's wake vortex, a source of problems in aerial application of spray material. The vortex, as seen here, exerts a powerful influence on the flow field behind the airplane.

problem of predicting ground deposit pattern changes, either due to dispersal system changes or to aerodynamic modification to the airplane. Second, the code will be applied to the problem of evaluating the influence of aircraft operating procedures such as airspeed or altitude on ground deposit patterns."

One aerodynamic modification of the airplane during flight test was the addition of winglets, relatively small vertical wing surfaces at the wing tips. AGDISP correctly predicted that the modification would improve spray results. The swirling vortex of air that normally comes off the wing tip was displaced to near the tip of the winglet. Without winglets, the vortex was lower, closer to the spray nozzles and tended to entrain more particles around the vortex, contributing to the drift problem.

The code will help an operator determine whether or not to spray under existing wind conditions and the best operational flight conditions for a given set of atmospheric conditions.

The flight tests discovered that maintaining the target altitude is critical for achieving the predicted ground distribution, but that airspeed variations have relatively little effect.

The U.S. Air Force and Lockheed-Georgia Corp. are working with Langley to apply knowledge from AGDISP to the design of a new dispersal system to be mounted on Lockheed C-130 aircraft to spray mosquitoes. The State Department is using information gained from a spray system designed and tested by Langley, at the department's request, for high-speed, high-altitude spraying of illicit drugs. Future users may even include ultralight aircraft companies considering a move into aerial applications.

Agency-Sponsored Development Opportunities

NASA supplements installation management development efforts by sponsoring a number of internal and external education and work experience programs for selected employees. The annual cycle for selection is underway. Your local training office has program information and nomination procedures. These programs include:

Program	Length	Preferred Grade Level	Program Schedule	Nomination Due
External Education Programs:				
Federal Executive Institute				Oct. 1, 1984
• Senior Executive Education Program	7 Weeks	SES	84/85 Schedule	
• Executive Leadership and Management	3 & 4 Weeks	15-SES	84/85 Schedule	
Office of Personnel Management				Aug. 1, 1984
• Executive Development Seminars	2 Weeks	15-SES	84/85 Schedule	
• Management & Sci/Technology Seminars	2 Weeks	13-15	84/85 Schedule	
Fellowship Programs:				
Carnegie-Mellon University				Oct. 1, 1984
• The Senior Executive Seminar	3 Weeks	15-SES	May 1985	
Dryden University Fellowship	10 Months	14-SES	Sep. 85-June 86	
Harvard University				
• Program for Management Development	14 Weeks	15-SES	Fall 85/Spr. 86 Sem.	
• Senior Executive Fellows	13 Weeks	15-SES	Fall 85	
• Senior Managers in Government	3 Weeks	15-SES	Aug. 85	
ICAF (Industrial College of the Armed Forces)	11 Months	15-SES	Aug. 85-June 86	
Massachusetts Institute of Technology				
• Advanced Study Program	13 Weeks	15-SES	Fall 85/Spr. 86 Sem.	
Simmons College				
• Middle Management Program	10 Weeks	12-14	Fall 85	
Sloan Program				
• Massachusetts Institute of Technology	1 Year	15-SES	June 85-June 86	
• Stanford University	9 Months	15-SES	Sep. 85-June 86	
Syracuse University				
• Maxwell Midcareer Development Program	15 Weeks	14-SES	Fall 85/Spr. 86 Sem.	
Developmental Work Assignment Programs				
Internal				Feb. 15, 1985
Career Development Program (CDP)	1 Year	13-14	Sep. 85-Aug. 86	
Critical Assignment Development Program (CADP)	Optional	13-SES	Negotiable	
Executive Development Work Experience Program (EDWEP)	Optional	SES	Negotiable	
SES Candidate Development Program (SESCDP)	12-18 Mos.	15	Sep. 85-Aug. 86	
External				
Congressional Fellowship Program	10 Months	15-SES	Nov. 84-Aug. 85	Oct. 1, 1984
Congressional Secretarial Fellowship Program				
• Congressional Caucus on Science and Technology	12 Months	7-9	Aug. 85-Aug. 86	Feb. 15, 1985
• Congressional Caucus on Women's Issues	12 Months	7-9	Aug. 85-Aug. 86	
Legis Fellows Program	6 Months	15-SES	Winter/Spring/ Summer Sessions	Oct. 1, 1984
President's Executive Exchange Program (PEEP)	1 Year	SES	Negotiable	Feb. 15, 1985

Program	Length	Preferred Grade Level	Program Schedule	Nomination Due
Management Education Center:				
Management Education Program				
• MEP XXX	2 Weeks	14-15	Dec. 4-15, 1984	Names will be
• MEP XXXI			Feb. 25-Mar. 8, 1985	requested 6-8
• MEP XXXII			June 3-14, 1985	weeks prior to
• MEP XXXIII			Sept. 9-20, 1985	session date
SEP/MEP Follow-On Seminars			Announced 90 Days	
• (Seminar to be Announced)	1 Week	SEP/MEP Grad.	in advance	
• (Seminar to be Announced)				
• (Seminar to be Announced)				
• (Seminar to be Announced)				
Project Management Shared Experience Program	5 Days	13-SES		
• PMSEP				
• PMSEP				
Senior Executive Program	8 Days	SES		
• SEP VI				
• SEP VII				

* The program guidelines represent generally accepted criteria for participation. However, variance in organization structure may create a necesity for exceptions.

Contractor News

NASA has awarded a contract to **Pan American World Services, Inc.,** for providing facility operating services at the National Space Technology Laboratories (NSTL) in Hancock County, Miss. Estimated value of the contract is $110 million for a five-year period, including options. The contract calls for a broad range of services including Space Shuttle main engine testing support, facilities engineering, operation and maintenance of specialized facilities and institutional services. NSTL's assigned mission includes technical support for the development of large liquid rocket propulsion systems, conducting research and development in the field of space applications, and hosting and supporting some 17 federal and state agencies in residence at the installation involved in scientific research, development and operations in the fields of oceanography, meteorology and earth sciences.

Marshall Space Flight Center, Huntsville, Ala., has awarded contracts to **Lockheed Missiles & Space Co.,** Sunnyvale, Calif., and **TRW, Inc.,** Redondo Beach, Calif., to define a highly advanced X-ray telescope called AXAF—the Advanced X-Ray Astrophysics Facility. Lockheed and TRW were selected for concurrent definition studies to examine in detail the basic concepts developed for the mission. Ultimately one of the two firms would be chosen for building the telescope. The contracts, 24 months in duration, will be in the range of $4 million for each company selected, with the total dollar value of the contracts to be approximately $8 million. Work performed under these firm fixed contracts will be at the plants of the selected companies. Proposed for launch in the early 1990s, the advanced observatory would be technologically superior to any X-ray facility previously sent into space. Weighing about 10 tons and measuring about 14 by 43 feet, it would be carried by the Space Shuttle and placed in an orbit 320 miles above the earth for operation over a lifetime of about 15 years.

Johnson Space Center, Houston, Texas, has selected **GTE Systems,** Needham Heights, Mass., for negotiations leading to a cost-reimbursement contract for Space Shuttle wireless crew communications equipment. Under the contract, GTE will design, develop and manufacture a flight crew communications system for the Shuttle orbiters to provide continuous duplex voice for up to seven astronauts without a maze of wires. The system will use low power radio frequency carriers. The two-year contract, beginning July 1984, will have an estimated cost and fee total of $4,431,000.

1984 Launch Activity

Space Shuttle Launches

Date	Mission	Orbiter	Launch Site*	Remarks
Feb. 3	41-B	Challenger (OV-099)	KSC	Payload: SPAS-01A, Palapa B-2, Westar-VI; successful launch; landing at KSC, Feb 11.
April 6	41-C	Challenger (OV-099)	KSC	Payload: Solar Maximum Repair Mission; Long Duration Exposure Facility
Aug. 24	41-D	Discovery (OV-103)	KSC	Payload: LEASAT-1, Telstar 3-C, SBS-D, OAST-1; first flight of Discovery.
Oct. 1	41-G	Challenger (OV-099)	KSC	Payload: OSTA-3; ERBS
Nov. 2	51-A	Discovery (OV-103)	KSC	Payload: MSL-1, Telesat-H, GAS Bridge
Dec. 9	51-C	Discovery (OV-103)	KSC	Payload: DOD Mission

Satellite Deployments from the Shuttle

Date	Satellite	Deployment Device/** Upper Stage	Shuttle Mission	Remarks
Feb. 3	Westar-VI	PAM-D	41-B	Western Union communications; successful deployment from STS 41-B; satellite failed to achieve geosynchronous orbit.
Feb. 6	Palapa B-1	PAM-D	41-B	Indonesia communications: successful deployment from STS 41-B; satellite failed to achieve geosynchronous orbit.
April 7	LDEF	RMS	41-C	Long Duration Exposure Facility; successful deployment.
August	Syncom IV-1	UUS	41-D	Hughes communications
August	SBS-D	PAM-D	41-D	Satellite Business Systems commercial communications
August	Telstar 3-C	PAM-D	41-D	AT&T communications
Oct. 1	ERBS	RMS	41-G	Earth Radiation Budget Satellite
Nov. 2	Telesat-H	PAM-D	51-A	Canadian communications

Expendable Launches

Date	Mission	Launch Vehicle	Launch Site	Remarks
March 1	Landsat 5	Delta	WSMC	National Oceanic and Atmospheric Administration; earth observation; successful launch.
June 9	Intelsat V-G	Atlas Centaur	ESMC	Intelsat international communications; satellite not in proper orbit due to Centaur stage malfunction
Aug. 9	AMPTE	Delta	ESMC	Active Magnetospheric Particle Tracer Explorer; space physics — NASA cooperative with Germany
Sept. 13	Galaxy-C	Delta	ESMC	Hughes commercial communications satellite
October	NOAA-F	Atlas-F	WSMC	National Oceanic and Atmospheric Administration weather satellite
October	NATO-IIID	Delta	ESMC	North Atlantic Treaty Organization communications
4 Qtr.	AF-16 (ITV-1)	Scout	WFF	U.S. Air Force
4th Qtr.	Navy 21	Scout	WFF	U.S. Navy
Under assessment	Intelsat VA-B	Atlas Centaur	ESMC	Intelsat international communications

* **Launch Sites:** ESMC — Eastern Space and Missile Center, Fla.; KSC — Kennedy Space Center, Fla.; SMR — San Marco Range, Indian Ocean; WFF — Wallops Flight Facility, Wallops Island, Va.; WSMC — Western Space and Missile Center, Vandenberg Air Force Base, Calif.

** **Separation Device/Upper Stage:** IUS — Inertial Upper Stage; PAM-D — Payload Assist Module; RMS — Remote Manipulator System; UUS — Unique Upper Stage

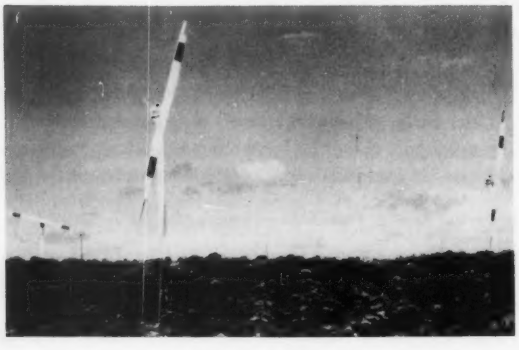
Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Wind Turbines

At right is the world's most powerful wind turbine, which went into operation last year near Medicine Bow, Wyo. Designated WTS-4, the system employs a 256-foot-diameter rotor blade to convert wind force into 4,000 kilowatts of electrical energy, enough to meet the electrical needs of about 1,000 homes. The WTS-4 was developed by Hamilton Standard Division of United Technologies Corp. under NASA technical direction and Department of the Interior sponsorship. Along with a 2,500 kilowatt MOD-2 wind turbine at the same site, the WTS-4 is undergoing a two-year evaluation that could lead to construction at Medicine Bow of a "wind farm" with as many as 40 machines.

Shown below is the world's highest capacity wind turbine installation, a cluster of three MOD-2 systems—each with a 300-foot-diameter blade—that collectively generate 7,500 kilowatts. The cluster is operated by the Bonneville Power . Administration, which feeds the electricity produced into the northwest power grid for use by regional utilities. These turbines were built by Boeing Engineering and Construction Co. in a NASA/Department of Energy program aimed at development of advanced technology wind systems as alternative power sources. Managed by Lewis



Research Center, Cleveland, Ohio, the program involves development and test of a number of differently sized turbines in different geographical locations under varying wind conditions. NASA has acquired more than 40,000 hours of large wind turbine experience since the first intermediate size (200 kilowatts) machine started operating in 1977. In design status is the most powerful wind turbine yet, a MOD-5 system that will generate 7,000 kilowatts in a single unit.

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.